Sign language semantics, Day 3: Plurality and dependency (verbs)

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Section 1

Overview: plurality and dependency
Different kinds of plurality in natural language

(1) I saw zebras.

(2) The boys read one book each.

(3) John coughed again and again.

(4) All the dogs licked the same cat.

(5) Each dog licked a different cat.
Plurality and dependency

(4) All the dogs licked the same cat.

- ‘external reading’: compares another individual in context.
- ‘internal reading’: compares dogs to each other.

- Only a single cat, but a plurality of lickings.

- The internal reading of same is licensed by the presence of a plural elsewhere in the sentence.

(6) * Fido licked the same cat.

(on internal reading)
Cross-linguistic, cross-categorial dependency

The internal reading of *same* is an instance of a much larger pattern of *dependency* cross-linguistically.

**Nouns:** inflection on a DP may indicate that a plurality of individuals are distributed across another plurality.

(7) **Kaqchikel Mayan** (Henderson 2014)

a. Xeqatij ox-ox wäy.
   we-eat three-three tortilla
   ‘We each ate three tortillas.’

b. * Xe’inchäp ox-ox wäy.
   I-handle three-three tortilla

* Desired reading:* ‘I took (groups of) three tortillas.’
Cross-linguistic, cross-categorial dependency

- **Verbs**: inflection on a verb may indicate that a plurality of events is distributed in some way.

\[(8) \textbf{Chechen} \ (\text{Wood 2007 via Cabredo Hofherr & Laca 2012})\]

a. Bombanash \underline{lilxira}.
bomb.PL explode.PLR.WP
‘The bombs exploded.’

b. # Bomba \underline{lilxira}.
bomb.SG explode.PLR.WP
‘The bomb exploded again and again.’

- Distribution across participants is licensed by a plurality elsewhere in the sentence.
Theoretical questions:

▸ What is the semantic contribution of these dependent forms?

▸ What is the link between a dependent term and its licensor?
Plurality in sign language!

- Sign languages (ASL, LSF, ...) make a very intuitive, morphological natural class out of these constructions.
  - Semantic objects corresponding with nominal plurality are arranged in space in the horizontal plane.
  - Semantic objects corresponding to verbal plurality (i.e. multiple events) involve a repeated motion.

- The use of space and iconicity in sign language shed new light on theoretical questions.
Verbal plurality

Example 1 (French Sign Language):

(9) OFTEN ONE PERSON FORGET-rep ONE WORD.

“One person repeatedly forgot a word.”
Verbal plurality

Example 2 (French Sign Language):

MY FRIENDS IX-arc ARRIVE-alt.
‘My friends each arrived.’
Today: verbal plurality
Tomorrow: nominal plurality
Verbal plurality

(Joint work with Valentina Aristodemo)
Section 2

Background: events and plurality
Events

- We will be assuming a semantic ontology that includes events.
- Events are minimal parts of the world.
  - E.g. there is an event in which John kisses Bill—no other information about the world is included in this event.
- Verbs denote sets of events.
Events – motivation

(11) The boy pushed the dog with a bone.

► Reading 1: \([\text{dog}] \cap [\text{with a bone}]\)
  ► both of these are sets of individuals

► Reading 2: \([\text{pushed the dog}] \cap [\text{with a bone}]\)
Events – motivation

(12) The boy pushed the dog with a bone.

- Reading 1: [dog] \(\cap\) [with a bone]
  - both of these are sets of individuals

- Reading 2: [pushed the dog] \(\cap\) [with a bone]
  - = the set of individuals who pushed the dog
  - \(\cap\) the set of individuals with a bone?
  - ...no...
Events – motivation

(13) The boy pushed the dog with a bone.

- Reading 1: \([\text{dog}] \cap [\text{with a bone}]\)
  - both of these are sets of individuals

- Reading 2: \([\text{pushed the dog}] \cap [\text{with a bone}]\)
  - \(= \text{the set of individuals who pushed the dog} \cap \text{the set of individuals with a bone?}\)
  - ...no...
  - \(= \text{the set of individuals who pushed the dog} \cap \text{the set of individuals who used a bone as a tool?}\)
  - ...still not right; need to tether the pushing and the bone...
Events – motivation

Better:

▶ Reading 2: \([\text{pushed the dog}] \cap [\text{with a bone}]\)  
= the set of events in which the dog was pushed  
\cap the set of events in which the bone was used as a tool

As we will see, very useful for plurality, too!
The logical form of a sentence in event semantics

(14) The boy pushed the dog with the bone

\[ \exists e[\llbracket \text{push} \rrbracket (e) \land \text{agent}(e) = i[\text{boy}] \land \text{patient}(e) = i[\text{dog}] \land \text{instrument}(e) = i[\text{bone}]] \]

‘There is a pushing event of which the boy is the agent, the dog is the patient, and the bone is the instrument.’
We will assume that both individuals and events show mereological structure.

\[ \text{mereology} = \text{the study of parthood} \]

‘\( \preceq \)’ defines a partial order; \( x \preceq y \) means that \( x \) is part of \( y \).

- E.g. Ann is part of the plurality containing Ann, Ben, and Cat.

**Summation:**
\( x \oplus y \) is the smallest object \( z \) such that \( x \preceq z \) and \( y \preceq z \).

- **Note:** if \( x \) and \( y \) are type \( \alpha \), \( x \oplus y \) is also type \( \alpha \).
The star operator

The star-operator, written *, returns the algebraic closure of a set with respect to sum formation.

\[ *P = \{ x | \exists P' \subseteq P [ x = \bigoplus P'] \} \]

‘*P is the set of all objects that can be made by summing non-empty subsets of P.’

Example:

\[ P = \{ a, b, c \} \]
\[ *P = \{ a, b, c, a \oplus b, a \oplus c, b \oplus c, a \oplus b \oplus c \} \]
Plural nouns

- The meaning of the plural suffix /-s/ is just the star operator.

(16) There is a boy in the room.

\[
\llbracket\text{boy}\rrbracket = \{a, b, c\}
\]

(17) There are boys in the room.

\[
\llbracket\text{boys}\rrbracket = \star\llbracket\text{boy}\rrbracket = \{a, b, c, a \oplus b, a \oplus c, b \oplus c, a \oplus b \oplus c\}
\]

- ‘the’ takes the unique maximal salient plurality in a set

(18) \llbracket\text{the boys}\rrbracket = a \oplus b \oplus c
Inherently pluralized verbs

▶ Observation: on cumulative readings, (unmarked) verbs can denote plural events.

(19)  The boys left.
(20)  Two girls invited three boys.

▶ Assumption: lexical predicates are inherently pluralized with the star operator. (Krifka 1992 and Kratzer 2008)

▶ *Arrive* denotes the set of all singular or plural arriving events.
Additionally, there are **distributivity operators**, relatives of the star operators, that may pluralize a predicate at other points in the derivation.

(21) The boys each read one book.

\[
\lbrack \text{read 1 book} \rbrack = \lambda e [\text{read}'(e) \land \text{pat}(e) \in \text{book} \land |\text{pat}(e)| = 1]
\]

Assume ‘each’ \(\approx\) the star operator

What’s the meaning of \([\text{each read one book}]\)?
Section 3

Pluractionality
Pluractionality

- In many languages of the world, verbs show “pluractional” inflection, often created by reduplication.

- These contribute the notion that the sentence in some way describes a ‘multitude’ of events.
  - An event happened again and again
  - Many things happened at the same time
Pluractionality along many dimensions

- Upriver Halkomelem (Thompson 2009):

\[(22) \quad \text{yáleq'} -\text{et} -\text{es te theqát} \quad (\text{cf. yáq'}-\text{et})
\]
\[
\text{fell.pl} \quad -\text{tr.} \quad -3S \text{ det. tree}
\]

- True if ...
  - a. He felled the trees. (all in one blow, or one after the other)
  - b. He felled the same (magic) tree over and over.
  - c. They felled the tree.
  - d. They felled the trees.

- False if ...
  - e. He felled the tree (once).
Pluractionality along many dimensions

- ‘They felled the trees at the same time’
- ‘He felled the same tree over and over’
- ‘He felled one tree one time’

► Pluractional means: “you have more than one line.”
In LSF, too, verbs may be modified with reduplication to indicate pluractionality.

There are at least two different morphemes that appear across a wide range of verbs.

/-rep/ is full repetition of the exact same motion of the verb
/-alt/ is alternating repetition of the two hands

Examples:

FORGET
ARRIVE
GIVE

LEAVE
SPIT
TAKE
Pluractionality in French Sign Language

**LSF:** GIVE (singular), GIVE-rep, GIVE-alt
Pluractionality in French Sign Language

**LSF:** FORGET (singular), FORGET-rep, FORGET-alt
Pluractionality in French Sign Language

- What is the difference in meaning?

- Roughly:
  - FORGET\-rep = forget again and again
  - FORGET\-alt = forget many things
    OR
    many people forget

- Exactly the same dimensions of pluractionality as earlier; /-alt/ and /-rep/ carve up the space of pluractional meanings.
/alt/: distribution over participants

- /-alt/ entails that subevents have different participants.
- Thus, needs to be licensed by a plural in an argument position.

(23) GROUP PEOPLE BOOK GIVE-1-alt.  
    ‘A group of people gave me books.’

(24) ONE PERSON FORGET-alt SEVERAL WORDS.  
    ‘One person forgot several words.’

- Although (23)-(24) are compatible with events spread over time, distribution over time alone is not sufficient for /-alt/.

(25) * (OFTEN) ONE PERSON FORGET-alt ONE WORD.  
    \textit{Intended}: ‘One person (often) forgot one word.’
/rep/: distribution over time

In contrast, /-rep/ entails distribution over time.

(26) OFTEN ONE PERSON FORGET-rep ONE WORD.
    ‘One person often forgot one word.’

(27) MIRKO BOOK a-GIVE-1-rep.
    ‘Mirko gave me a book repeatedly.’

Distribution over time, even with a plural argument.

(28) MY FRIENDS CL:plural FORGOT-rep BRING CAMERA
    ‘My friends repeatedly forgot to bring a camera.’
    a. √ several times; each time, all forgot
    b. * a single time; all forgot
/-rep/ vs. /-alt/  

a. distribution over only time  

b. distribution over only participants  
c. distribution over participants and time

\[
\begin{array}{c|c|c}
\text{-rep/} & \text{-alt/} \\
\checkmark & * \\
\checkmark & \checkmark \\
* & \checkmark 
\end{array}
\]
Question: how is plurality introduced?

(29)  

a. Every three seconds, John coughed once.

b. John coughed repeatedly for several minutes.

▶ Intuitively different.
▶ Let me anticipate, and suggest that the analytic difference is the following:
  ▶ ‘every three seconds’ is a pluralizing operator (like *)
  ▶ ‘repeatedly’ is a filter, leaving only non-atomic events
▶ How can we test empirically?
Question: how is plurality introduced?

An empirical difference:

(30) a. John read one book every week.  
✓ many books ✓ one book  
*many books ✓ one book

(31) a. Every three seconds, John ate one strawberry.  
b. # John ate one strawberry repeatedly.
Making indefinites dependent

► Why is this? Suppose:
  ► $e_1 \vdash$ Alice read *The Left Hand of Darkness* Monday
  ► $e_2 \vdash$ Alice read *American Gods* Monday
  ► $e_3 \vdash$ Alice read *Catch-22* Monday
  ► $e_4 \vdash$ Alice read *Catch-22* Tuesday
  ► $e_5 \vdash$ Alice read *Catch-22* Wednesday

► $\llbracket$ read one book $\rrbracket = \lambda e. \llbracket$ read $\rrbracket(e) \land \text{theme}(e) \in book \land |\text{theme}(e)| = 1$

► $\llbracket$ read one book $\rrbracket = \{ \}$
Making indefinites dependent

▸ Why is this? Suppose:
  ▸ $e_1 \vdash$ Alice read *The Left Hand of Darkness* Monday
  ▸ $e_2 \vdash$ Alice read *American Gods* Monday
  ▸ $e_3 \vdash$ Alice read *Catch-22* Monday
  ▸ $e_4 \vdash$ Alice read *Catch-22* Tuesday
  ▸ $e_5 \vdash$ Alice read *Catch-22* Wednesday

▸ $\llbracket \text{read one book} \rrbracket = \lambda e. \llbracket \text{read} \rrbracket (e) \land \text{theme}(e) \in \text{book} \land |\text{theme}(e)| = 1$

▸ $\llbracket \text{read one book} \rrbracket = \{ e_1, e_2, e_3, e_4, e_5, e_3 \oplus e_4, e_3 \oplus e_5, e_4 \oplus e_5, e_3 \oplus e_4 \oplus e_5 \}$
Making indefinites dependent

Why is this? Suppose:

- $e_1 \vdash$ Alice read *The Left Hand of Darkness* Monday
- $e_2 \vdash$ Alice read *American Gods* Monday
- $e_3 \vdash$ Alice read *Catch-22* Monday
- $e_4 \vdash$ Alice read *Catch-22* Tuesday
- $e_5 \vdash$ Alice read *Catch-22* Wednesday

\[
\llbracket \text{read one book} \rrbracket = \\
\lambda e. \llbracket \text{read} \rrbracket (e) \land \text{theme}(e) \in \text{book} \land |\text{theme}(e)| = 1
\]

\[
\llbracket \text{read one book} \rrbracket = \\
\{ e_1, e_2, e_3, e_4, e_5, e_3 \oplus e_4, e_3 \oplus e_5, e_4 \oplus e_5, e_3 \oplus e_4 \oplus e_5 \}\n\]

\[
\llbracket \text{read one book repeatedly} \rrbracket = \\
\{ \}
\]
Making indefinites dependent

Why is this? Suppose:

\[ e_1 \vdash \text{Alice read } The \ Left \ Hand \ of \ Darkness \ Monday \]
\[ e_2 \vdash \text{Alice read } American \ Gods \ Monday \]
\[ e_3 \vdash \text{Alice read } Catch-22 \ Monday \]
\[ e_4 \vdash \text{Alice read } Catch-22 \ Tuesday \]
\[ e_5 \vdash \text{Alice read } Catch-22 \ Wednesday \]

\[ \llbracket \text{read one book} \rrbracket = \lambda e. \llbracket \text{read} \rrbracket (e) \land \text{theme}(e) \in \text{book} \land |\text{theme}(e)| = 1 \]

\[ \llbracket \text{read one book} \rrbracket = \{ e_1, e_2, e_3, e_4, e_5, e_3 \oplus e_4, e_3 \oplus e_5, e_4 \oplus e_5, e_3 \oplus e_4 \oplus e_5 \} \]

\[ \llbracket \text{read one book repeatedly} \rrbracket = \{ e_3 \oplus e_4, e_3 \oplus e_5, e_4 \oplus e_5, e_3 \oplus e_4 \oplus e_5 \} \]
Question: how is plurality introduced?

Two possibilities:

- /-alt/ and /-rep/ pluralize a singular event
  - i.e., they are equivalent to the star operator.
  - /-alt/ would be similar to English *each*
- They are a cardinality checker on a previously pluralized predicate.
Differences in predictions

(32)  
a. EVERY-DAY JEAN ONE WORD FORGET.  
   ‘Every day, Jean forgot one word.’  
   ✓many words ✓one word

b. JEAN ONE WORD FORGET-rep.  
   ‘Jean forgot one word repeatedly.’  
   *many words ✓one word

(33)  
a. STUDENT EACH FORGOT ONE WORD.  
   ‘Each student forgot one word.’  
   ✓many words ✓one word

b. STUDENT IX-arc FORGOT-alt ONE WORD.  
   ‘The students forgot (the same) one word.’  
   *many words ✓one word
### Empirical summary

<table>
<thead>
<tr>
<th>(34)</th>
<th>operator</th>
<th>filter</th>
</tr>
</thead>
<tbody>
<tr>
<td>participants</td>
<td>EACH</td>
<td>-alt</td>
</tr>
<tr>
<td>time</td>
<td>EVERY-DAY</td>
<td>-rep</td>
</tr>
</tbody>
</table>
Formally, we can give a small modification to existing analyses of pluractionals (Lasersohn 1995).

\[(35)\quad [-\text{alt}] = \lambda Ve[V(e) \land \exists e', e'' \preceq e[\theta(e') \neq \theta(e'')]]\]

‘/-alt/ takes a verb denotation \(V\) and gives the set of \(V\)-ing events that have at least two subparts with different thematic arguments.’

\[(36)\quad [-\text{rep}] = \lambda Ve[V(e) \land \exists e', e'' \preceq e[\tau(e') \neq \tau(e'')]]\]

‘/-rep/ takes a verb denotation \(V\) and gives the set of \(V\)-ing events that have at least two subparts with different runtimes.’

\*\(V\) gives the algebraic closure of \(V\); \(\preceq\) indicates parthood; \(\theta(e)\) is a tuple of the participants of an event: \(\langle \text{ag}(e), \text{th}(e), \ldots \rangle\), \(\tau\) is runtime.
Section 4

A compositional puzzle
A compositional puzzle:

- /-alt/ requires a plural argument over which events can vary.
- /-alt/ is licensed by EACH, even though it distributes to atoms.

(37) a. * EACH BOY GATHER.
    b. BOY EACH FORGET-alt BRING CAMERA.
       ‘Each boy forgot to bring a camera.’

- This is formally identical to the puzzle of dependent indefinites under distributive quantifiers. (Balusu 2006, Henderson 2014)
A compositional puzzle

More precisely:

(38) EACH INVITE-alt GIRL.
    ‘Each one invited a girl.’

(39) $\exists e. \forall x [\textbf{atom}(x) \rightarrow \exists e'[e' \leq e \land *\text{invite}(e') \land \text{theme}(e') \in \text{girl}'] \land \text{agent}(e') = x \land \exists e'', e''' \leq e'[\theta(e'') \neq \theta(e''')]]...$
The temporal domain

A similar puzzle in the temporal domain:

(40) EVERY-DAY ONE BOOK JEAN GIVE-1-rep.

a. ‘Every day, Jean gave me one book.’ (preferred reading)

b. ‘Every day, Jean gave me one book repeatedly.’
Possible solutions

Two possible solutions.

Option 1:

- No built-in variation condition.
- Dependency marking is the expression of syntactic agreement with a higher operator that introduces pluractionality.
- This operator can be overt or covert.

(Oh 2001, 2005; Kimmelman 2015)
Scopable pluractionality

Option 2:

- The distributive quantifier introduces a plurality of events *from a global perspective*.

- The variation condition of /-alt/ is able to escape from the distributive scope of EACH to get access to this global plurality.
  - Henderson 2014: Dynamic plural logic with postsuppositions
  - Kuhn 2015, Ch. 4: DPLIL with Quantifier Raising

- The effect is that the plurality condition is evaluated as though attached at a higher node.
Scopable pluractionality

(41)

∃ ⟨vt, t⟩

-alt ⟨vt, vt⟩

- ⟨vt, vt⟩

EACH [ag] ⟨vt, vt⟩

INVITE ⟨vt⟩

GIRL [th] ⟨vt, vt⟩
Scopable pluractionality

\[ \exists \langle vt, t \rangle -rep \langle vt, vt \rangle \]

EVERY-DAY

\langle vt, vt \rangle

JEAN [ag]

\langle vt, vt \rangle

ONE BOOK [th]

\langle vt, vt \rangle

GIVE-1

\langle vt \rangle

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Sign language semantics, Day 3: Plurality and dependency (verbs)
Pluractionality Summary

Interim summary:

- The pattern of pluractional verbs in LSF fits perfectly into a broader typology of pluractionality in spoken languages.
- We established a compositional puzzle, and sketched a solution.

- But wait, there’s more...
Section 5

Iconicity
Additionally, an iconic mapping...

**Claim:** rate of reduplication is *iconically mapped* to the rate of the event repetition.

\[(43)\] a. GIVE-slow  b. GIVE-fast  c. GIVE-medium
Verb-internal gradience

GIVE-rep (accelerating), GIVE-rep (decelerating)
Gradience and iconicity

Of note, these mappings preserve gradient geometric information about the form of the sign.

Cannot be captured by a discrete, combinatorial system alone.

Acceleration (LSF):

Deceleration (LSF):
Iconicity: what’s (not) preserved

- In fact, it’s possible to preserve quite a lot of information:
  - E.g. speeding up, reaching a plateau, then decelerating again

- BUT, notably not preserved: the exact number of repetitions.
  - No inference for the “GIVE-rep (accel.)” example that the speaker gave something exactly eight times.

- General finding for sign language: “three means plural.”
- General cognitive finding (Carey 2009): relative cardinality judgements is easier than absolute cardinality judgements.
Iconicity: proposal sketch

▶ **Proposal:** Repetition associated not with a discrete set of points, but with a continuous distribution of events over time.

▶ The verb is true of any sequence of events which matches the same contour.
Iconicity in the grammar

- Now, notice that what we’ve just done is associate a verb with a set of plural events — in other words, we have a predicate type \( \langle v, t \rangle \) that we can pop into a formal definition.

\[
\text{(44)} \quad [-\text{alt}] = \lambda V e [V(e) \land \exists e', e'' \preceq e[\theta(e') \neq \theta(e'')]] \land \text{Icon}^\Phi(e)
\]

‘\(-\text{alt}\)/ takes a verb denotation \( V \) and gives the set of \( V\)-ing events that have at least two subparts with different thematic arguments and that have the temporal distribution shown.’

\[
\text{(45)} \quad [-\text{rep}] = \lambda V e [V(e) \land \exists e', e'' \preceq e[\tau(e') \neq \tau(e'')]] \land \text{Icon}^\Phi(e)
\]

‘\(-\text{rep}\)/ takes a verb denotation \( V \) and gives the set of \( V\)-ing events that have at least two subparts with different runtimes and that have the temporal distribution shown.’

- Following Schlenker, Lamberton & Santoro 2012, iconically-defined predicate incorporated directly into the formal system.
Section 6

Scopable iconicity
Two components of our proposal:

1. A combinatorial morpheme with iconic component:

\[
[-\text{alt}] = \lambda V e. \ (V(e) \land \exists e', e' < e[\theta(e') \neq \theta(e'')] \land \text{Icon}^\Phi(e)
\]

Logical component

2. Composition that allows /-rep/ and /-alt/ to take scope.

Prediction: ‘Scopable iconicity’
Scopable iconicity

Each boy gave papers.

Each boy gave papers.

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Scopable iconicity

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Scopable iconicity

Consider the case of the overworked secretary:

A set of slow event sequences may sum up to a plural event that occurs rapidly.

Prediction: The perspective of the iconic component depends on where the pluractional inflection takes scope.
Scopable iconicity

(47) JEREMY OBJECTS VARIOUS \textit{a-GAVE-1-alt-decelerating}. NEXT MIRKO VARIOUS OBJECTS \textit{b-GAVE-1-alt-decelerating}. SEVERAL \textit{c-GAVE-1-alt-decelerating}. EACH-abc \textit{abc-GAVE-1-alt-accelerating} MORE FULL-UP ALONE.
Section 7

Conclusion
Conclusion

- Here, we focused on two reduplicative verbal forms in LSF.

- First, we showed that the meanings fit in with more general patterns of cross-linguistic pluractionality.
  - Distribution over time vs. distribution over participants

- Then, we argued that the sign language patterns additionally display iconic effects.
  - Critically: in comparative forms, gradient interpretation.

- We proposed a single compositional system, and discussed implications for a recent compositional debate.
Thanks!

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Bibliography III


Bibliography IV


At-issue iconicity

Iconic meanings may scope under negation.

(48) MIRKO BOOK GIVE-rep-speeding-up NOT. IX BOOK give-rep-slowing-down DOWN.
‘Mirko didn’t give books at an accelerating rate. He gave books at a decelerating rate.’

Iconic meanings may scope low in the antecedent of a conditional.

(49) IF MIRKO PAPERS GIVE-rep-speeding-up, IX SECRETARY HAPPY.
‘If Mirko gives papers at an accelerating rate, the secretary will be happy.’
At-issue iconicity

- Iconic meanings may scope under distributive operators.

\[(50)\] **ASL**

EACH WORKER SECRETARY PAPER GIVE-rep-slow.
BUT, MANY WORKER NUMEROUS, ONE SECRETARY.
SO SECRETARY RECEIVE-alt-fast FAST.

‘Each worker gave the secretary papers *at a slow rate*. But there are many workers and one secretary. So the secretary received papers *at a fast rate*.’
Iconicity beyond sign language

(51) That was a loooong meeting.

(52) John coughed and coughed (and coughed).

(53) NBC: “Watch robots fall over again and again and again.”

► (In fact, 17 times over the course of one minute.)

Iconicity beyond sign language

Iconicity in a downward entailing environment? (h/t Chris Barker)